Recent development of the global 1/32° surface wave-tide-circulation coupled ocean model: FIO-COM32

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Introduction

- Model resolution and physical processes are two of the most important factors that determine the realism of the ocean model simulations.
- Recently, a brand new global 1/32°surface wave-tide-circulation coupled ocean model FIO-COM32 is developed and validated.
- Promotion of the horizontal resolution from 1/10° to 1/32°lead to great improvements of the simulated surface eddy kinetic energy (EKE), fine structures of sub-mesoscale to mesoscale movements and global tide accuracy.
- The non-breaking wave induced mixing (Bv) is proved to be an important contributor that improves the agreement of the summer mixed layer depth (MLD) between the new 1/32° model and the Argo observations.
- Internal tide (IT) can be explicitly simulated in this new model and is compared with the satellite observations.

Model decription and experiments design

wave model	ocean model	spatial resolution	vert. mixing	tide	ATM	IC
MASNUM	MOM5	1/32°×1/32°× 57levels	KPP+Bv	8-con tidal potential	NCEP GFS 0.25	FIO-COM 1/10° global OFS

EXP1: no Bv no tide, time period: 20160601-20191201;
EXP2: with Bv and tide, time period: 20170701-20191201.
EXP2 branches from EXP1 on 20170701. The analyzed period is 20180101-20191231. The output frequency of all experiments is daily.

Results

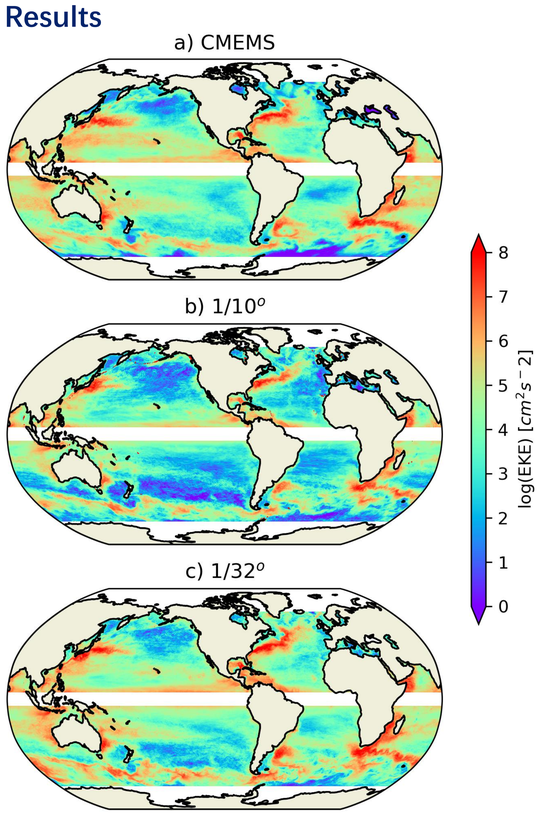

Figure 1 Natural logarithm of eddy kinetic energy (EKE) of CMEMS all satellite merged grided data (a), FIO-COM 1/10° (b) and 1/32° model results (c)

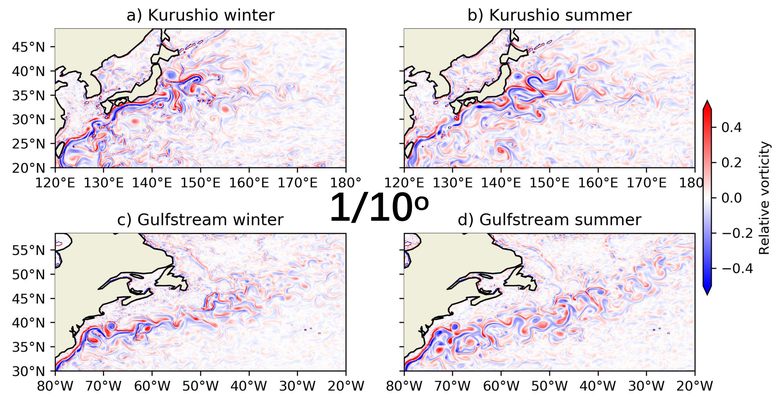

Figure 2 Relative vorticity of sea surface current of 1/10° model, snapshots of winter (20190301) (a) and summer (20190901) (b) of Kuroshio region, and that of Gulfstream region (c, d).

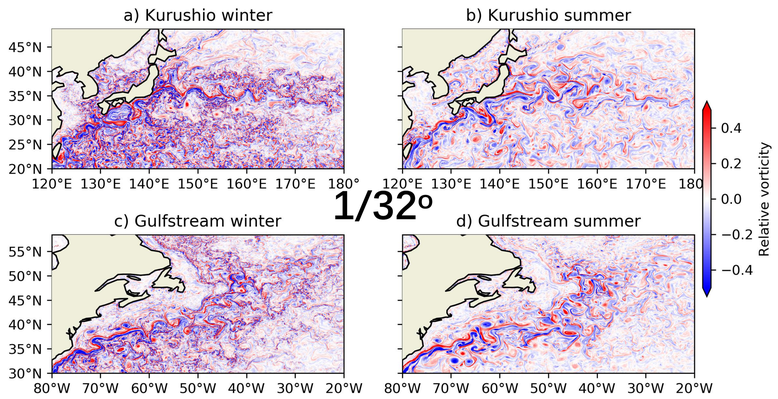

Figure 3 Same as fig. 2 but for 1/32° model.

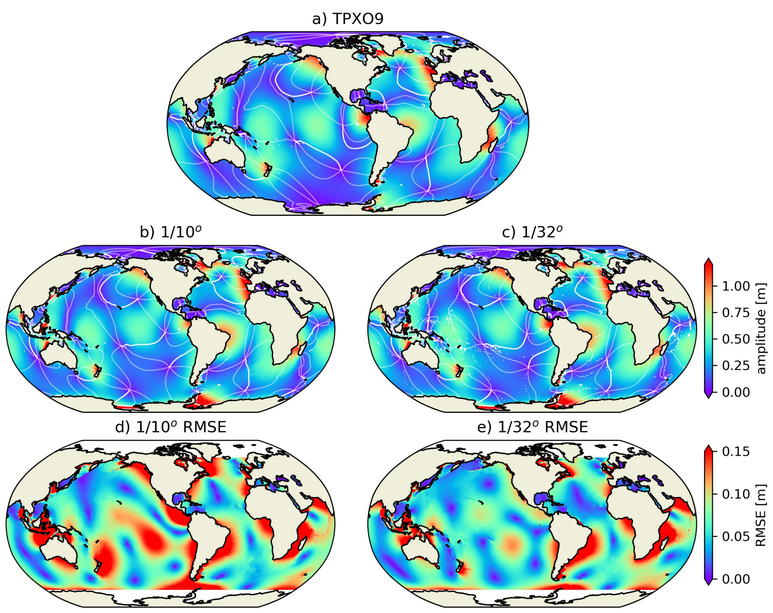

Figure 4 M_2 co-tidal charts of TPXO9 (a), barotropic version of 1/10° (b) and 1/32° (c) model, both have best tuned topographic drag. And their RMSE errors (d and e)

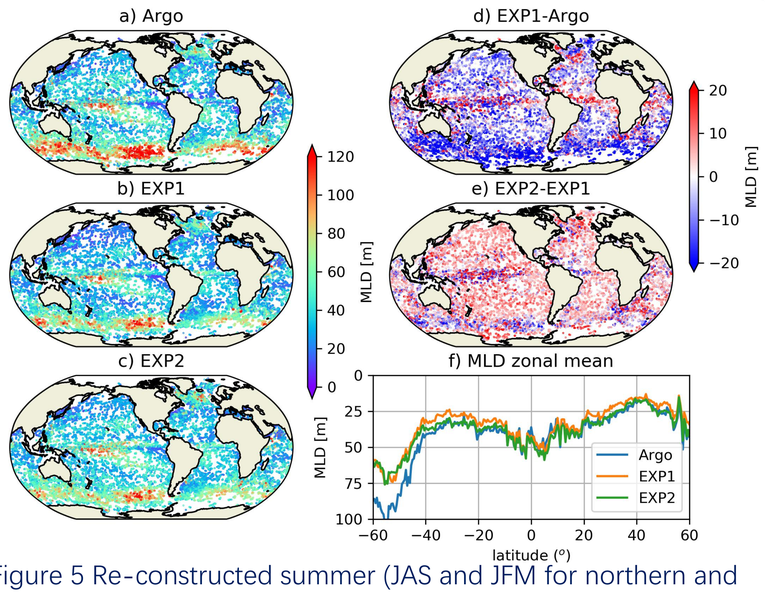

Figure 5 Re-constructed summer (JAS and JFM for northern and southern hemisphere respectively) MLD of Argo floats (a), EXP1 (b) and EXP2 (c). MLD difference between EXP1 and Argo, improvement of EXP2 compared with EXP1, and the MLD zonal averages are shown in (d), (e) and (f) respectively.

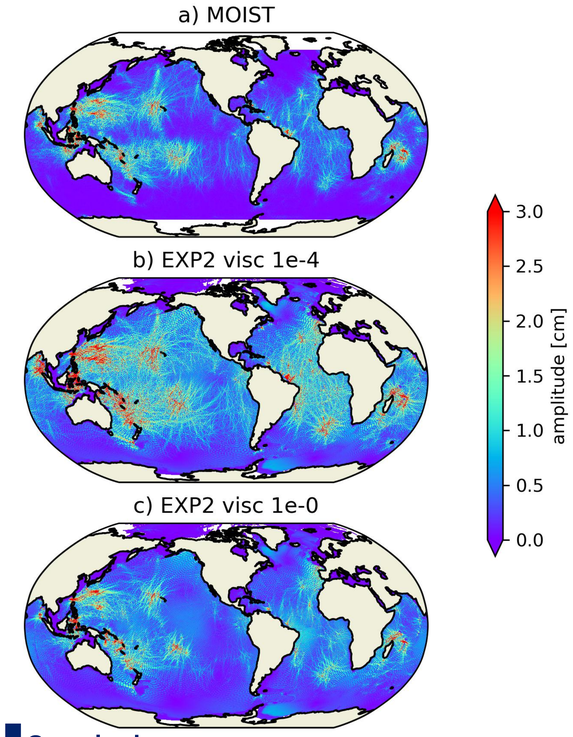

Figure 6 M_2 internal tide amplitude of MOIST observations (a), normal viscosity (1e-4) version of EXP2 (b), large viscosity(1.0) version of EXP2 (c)

Conclusions

1. The simulated surface eddy kinetic energy (EKE) is signifantly improved as the model resolution is increased from 1/10° to 1/32°;
2. 1/32° model shows much more vigrous sub-mesoscale and meso scale motions and more significant seasonal variablity than 1/10° model;
3. The global barotropic M_2 RMSE is decreased from 9.65 cm (1/10°) to 8.06 cm (1/32°)
4. Although the resolution is increased to 1/32°, the non-breaking wave induced mixing (Bv) is proved to be an important contributor that improves the agreement of the simulated summer mixed layer depth (MLD) of the model and the Argo observations.
5. Internal tide (IT) can be explicitly simulated in this new model, while more reasonable IT related energy dissipation may be needed and be developed in the future.